

CULTURAL AND MORPHOLOGICAL VARIABILITY OF *ALTERNARIA LINI* ISOLATES CAUSING BLIGHT OF LINSEED.

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ABSTRACT

Alternaria lini causes blight of linseed in India. The leaves showing typical symptoms of *Alternaria* blight, in linseed collected from different part of country and characterized for cultural, morphological, pathogenic and molecular variations. *Alternaria lini* colonies varied in respect of their colony colour (whitish, light brown to dark brown), growth pattern (slow, medium to fast), appearance (cottony, fluffy, feathery to compressed & thin), radial growth (25mm to 60mm), shape (circular), margin (wavy, rough to smooth), zonation (presence or absence), and sporulation (early, medium to late). Morphological variation in average conidial length (23.26 to 45.72 μ m), width (6.76 to 17.01 μ m), number of septa (1.86 to 5.60) and presence or absence of beak (unbeaked, rudimentary beaked and short beaked) were observed. Average conidial size ranged between 24x7 to 46x17 μ m.

KEYWORDS: *Alternarialini*, *Linum*, Cultural and Morphological Variability

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INTRODUCTION

Linseed (*Linum usitatissimum* L.), belongs to the family Linaceae and the genus *Linum* is commonly known as “*Ulse*” or “*Tisee*”. It contains 20 to 30% protein. Feeding linseed and its oil may be medicated in hyperlipidemia, to reduce and control arteriosclerosis, thrombosis and myocardial infarction, by reducing cholesterol and low density lipid (Vajpeyiet *al.*, 2005). Linseed oil is a triglyceride, like other fats. Linseed oil is distinctive for its unusually large amount of α -linolenic acid, which has a distinctive reaction with oxygen in air. Specifically, the fatty acids in a typical linseed oil are the tri -polyunsaturated α -linolenic acid (51.9-55.2%), the saturated acids palmitic acid (about 7%) and stearic acid (3.4-4.6%), the monounsaturated oleic acid (18.5-22.6%), the doubly unsaturated linoleic acid (14.2-17%). Among oilseed crops grown in India during *Rabi*. Linseed is next in importance to rapeseed- mustard in acreage as well as in production. India stands at fourth position in global production (Anonymous, 2013). Linseed is known to suffer from many diseases such as blight, rust, canker, damping off, leaf spot, root rot and wilt (Kolte and Fitt, 1997). *Alternaria* blight, earlier designated as a minor disease has assumed greatest importance, in different parts of the country, especially mid eastern India. *Alternaria* blight caused by *Alternaria lini* Dey and *A. linicola* Grooves and Skolko, is a major biotic stress, limiting crop yield in hot and humid environment (Singh and Singh 2004, 2005).

Out of two species of *Alternaria* known to occur on this crop, *Aternaria lini* is a more severe one. Survey of literature revealed that no information is available on variability of *A. lini* or *A. linicola* causing blight of linseed in India or outside of country. Since still no true resistance is available against this disease, it indicates the presence of variability in pathogen in different agro climatic zone of the country. To develop the resistant cultivar, it

requires stable resistant donor for this kind of variability in blight causing pathogen is necessary. Hence, present investigation was undertaken with pathogenic and molecular variability.

MATERIALS AND METHOD

The experiment was carried out in glass house, laboratories of Department of Plant Pathology and Plant Molecular Biology & Genetic Engineering (PMB&GE) of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U. P.) during year 2012-13 and 2013-14. Samples were collected from different agro climatic zones of India (Patna, Bilaspur, Sultanpur, Mauranipur, Mashodha, Kanpur, Kangra, Ranchi, Ranchi, Mirzapur, Gorakhpur, Berhampur, Kumarganj and Jammu). Potato-Dextrose-Agar medium was used for maintaining of pure culture of *Alternaria* species. Different media viz., Radish agar medium, Maize meal medium, Barley meal medium, Linseed leaf extract medium, Carrot agar medium as well as Potato Dextrose Agar medium were used for cultural studies of the *A. lini*. Effect of different culture media on colony colour, appearance, pattern of growth, shape, margin, zonatin, sporulation and radial growth of 12 isolates of *Alternarialini* on potato dextrose agar medium, radish agar medium, maize meal medium, barley meal medium, linseed leaves extract medium and carrot agar medium were observed from 7 days old culture. Morphological variability of 12 isolates were studied. The different characters viz. size of conidiophores and conidial characters such as length, width, colour, shape, and number of septa were studied on Potato Dextrose Agar (PDA) medium. The size of conidiophores and conidia were examined under microscope using ocular micrometry (Meena *et al.* 2005). Visual observation for septation was done by using light microscope (40X) taking 20 conidia from each slide. Length range and average length, width range and average width, range of horizontal septa of conidia and conidiophores were taken.

RESULTS AND DISCUSSIONS

Cultural variability

Variability of 12 isolates collected from different places studied by culturing them on different media (Potato dextrose agar medium, Barley meal medium, Radish agar medium, Carrot agar medium, Maize meal medium, and Linseed leaf extract medium) to find out their growth pattern, colonies colour, appearance, shape, margin, zonation and sporulation. The results obtained from the studies are discussed as under:

On potato dextrose agar medium the colonies colours of different isolates were noted as whitish, dirty white, light brown and dark brown. Variation on colonies colour of different isolates of *Alternaria solani* were studied by Kumar *et al.* (2007) and Singh *et al.* (2014) in case of tomato and they also reported variable colonies colour, such as brownish black, greenish black, reddish black, whitish black, and yellowish. Pramila *et al.* (2014) worked on variability of *Alternaria brassicae* isolates of Uttarakhand and reported whitish to grayish colonies colours. The variation of colonies colours in present study, supports the finding of above workers.

Besides PDA, colonies of isolates grown on radish agar medium showed dirty white (Al₁₀), light brown (Al₄, Al₆, Al₇, Al₈, Al₉, Al₁₁ and Al₁₂) and brown (Al₁, Al₂, Al₃ and Al₅) colours. Isolates also showed variation on maize meal medium as white (Al₁₀), dirty white (Al₁, Al₂, and Al₅) and light brown (Al₃, Al₄, Al₆, Al₈, Al₉, Al₁₁ and Al₁₂) colonies. On barley meal medium colonies colours of isolates were found dirty white (Al₉), light brown (Al₁, Al₂, Al₄, Al₆, Al₇, Al₈, Al₁₀, and Al₁₁) and brown (Al₃, Al₅, Al₇ and Al₁₂). Linseed leaf extract medium the colonies colours of 2 isolates (Al₁ and Al₂) were recorded brown, 8 (Al₃, Al₄, Al₅, Al₆, Al₇, Al₉, Al₁₀ and Al₁₂) light brown, remaining 2 whitish (Al₁₁) and dirty white (Al₈), respectively. On carrot agar medium variable colonies colours were also seen, in case of different isolates.

Seven isolates (Al₄, Al₆, Al₇, Al₈, Al₉, Al₁₀ and Al₁₁) gave light brown, four (Al₁, Al₂, Al₃ and Al₅) brown and one (Al₁₂) dirty white colour (Table.1& Fig.1, 2,3,4,5 and 6). Sharma *et al.* (2013) studied the on cultural variability of different isolates of *A. brassicae*, collected from different part of country, by using potato dextrose medium, cauliflower (host) agar medium and carrot potato agar medium and reported variable colonies colour. Besides these, several worker working with different species of *Alternaria*, causing blight disease in different crop have also studied the variability of colony colour on different medium and reported variability in colour of colonies produced by different isolate time to time (Vishwanath, 1999, Kumar *et al.* 2007, Singh *et al.*2009, Khulbeet *al.* 2009, Meena *et al.* 2012, Pramila *et al.* 2014 and Singh *et al.* 2014). Variability in colonies colour, recorded in present studies supports the finding of earlier workers. The medium used for the studies in case of *Alternaria lini* is of new kind because; it has not been used earlier by other workers in their studies, in case of other *Alternaria* spp. causing disease in different crops.

Radial growth of colonies formed by different isolates of *A. lini* were recorded, after 7 days of inoculation and found variable on different media. On potato dextrose agar medium radial growth of colonies, ranged between 25 mm (Al₁₂) to 52 mm (Al₁₁), on radish agar medium from 25 mm (Al₄) to 46 mm (Al₁₀), on maize meal medium from 25 mm (Al₁₂) to 50 mm (Al₅), on barley meal medium from 30 mm (Al₁₂) to 50 mm (Al₁₁), on linseed leaf extract medium from 38 mm (Al₆) to 60 mm (Al₁₁) and on carrot agar medium from 34 mm (Al₁₂) to 48 mm (Al₃). The isolates Al₁₁ collected from Berhampur (W. B.), showed maximum radial growth and isolate Al₆ obtained from Kanpur (U.P.) showed minimum growth on all the test media (Table 2 & Figure.1, 2,3,4,5 and 6). The shape of colonies formed by all the isolates on each media was noted circular. Variations in colonies growth (slow medium and fast) were also noted in different isolates on all the test media (Table.3& Figure.1, 2,3,4,5 and 6). All the isolates except Al₁₁ showed smooth margin of the colonies during their growth on potato dextrose agar medium, maize meal medium, linseed leaf extract medium, radish agar medium and carrot agar medium. Isolate Al₁₁ also showed smooth margin on these media except radish agar medium and maize meal medium on which it showed rough margin. All the isolates showed wavy margin on barley meal medium. Colonies formed by different isolates also showed variable appearance (cottony, feathery, fluffy and compressed & thin) during their growth. On maize meal medium all the isolates showed compressed & thin appearance. It may be due less availability of nutrients or organic matter in this crop (Table.4& Figure.1, 2,3,4,5 and 6). Most of the isolates under studies showed zonation on different media, only few have not shown zonation on some media during their colonies growth. Sporulation in different isolates on different media was also found variable. Some isolates showed early sporulation, some medium, some showed late sporulation on different media. On PDA most of the isolates, showed early sporulation except Al₄ and Al₆ which showed medium sporulation. On maize meal, medium and barley meal medium all the isolates showed medium sporulation. It is not as early as, in case of PDA. On radish agar medium all the isolates showed early sporulation except Al₆ and Al₁₀. Isolates on rest of the media showed either early or medium or late sporulation.

Concurrent with present findings, studies were also carried out by several workers in case of *Alternariabrassicae* isolates collected from different part of the country on variability of radial growth, colonies shape, colonies growth pattern, margin, appearance, zonation and sporulation and they reported 28.20mm to 81.10 mm radial growth, circular to wavy shape, feathery, fluffy to cottony appearance of colonies, presence or absence of zonation, and early, medium to late sporulation on potato dextrose agar medium (Khulbeet *al.* 2009., Goyelet *al.*2011., Sharma *et al.*2013 and Pramila *et al.*2014). Kumar *et al.* (2009) and Singh *et al.* (2014) have also obtained the variability in case of *Alternariasolani* isolates and reported variation in radial growth (14.90 to 35.50), colour of colonies (brownish black, greenish black, redish black and yellowish), shape (circular to irregular), growth pattern (slow, medium and fast), margin (smooth, rough and wavy),

appearance (fluffy, feathery and cottony), zonation (presence and absence) and sporulation (early, medium and late).

Table.1: Effect of Different Culture Media on Colony Colour of Different Isolates of *Alternaria Lini*

Media Isolates	PDA	Radish Agar Medium	Maize Meal Medium	Barley Meal Medium	Linseed Leaf Extract Medium	Carrot Agar Medium
Al ₁	Brown	Brown	Dirty white	Light brown	Brown	Brown
Al ₂	Brown	Brown	Dirty white	Light brown	Brown	Brown
Al ₃	Light brown	Brown	Light brown	Brown	Light brown	Brown
Al ₄	Dirty white	Light brown	Light brown	Light brown	Light brown	Light brown
Al ₅	Light brown	Brown	Dirty white	Brown	Light brown	Brown
Al ₆	Dirty white	Light brown	Light brown	Light brown	Light brown	Light brown
Al ₇	Light brown	Light brown	Light brown	Brown	Light brown	Light brown
Al ₈	Whitish	Light brown	Light brown	Light brown	Dirty white	Light brown
Al ₉	Dirty white	Light brown	Light brown	Dirty white	Light brown	Light brown
Al ₁₀	Dirty white	Dirty white	Whitish	Light brown	Light brown	Light brown
Al ₁₁	Light brown	Light brown	Light brown	Light brown	Whitish	Light brown
Al ₁₂	Light brown	Light brown	Light brown	Brown	Light brown	Dirty white

Table 2: Effect of Different Culture Media on the Mycelial Growth of Different Isolates of *Alternaria Lini* (Mm.)

Media Isolates	PDA	Radish Agar Medium	Maize Meal Medium	Barley Meal Medium	Linseed Leaf Extract Medium	Carrot Agar Medium
Al ₁	45	44	45	40	53	45
Al ₂	45	44	45	42	52	44
Al ₃	45	45	50	47	55	48
Al ₄	35	25	28	30	40	34
Al ₅	45	45	50	48	54	47
Al ₆	34	26	28	30	38	34
Al ₇	45	46	45	40	42	44
Al ₈	44	45	44	42	40	42
Al ₉	45	44	46	42	42	44
Al ₁₀	46	46	45	40	40	40
Al ₁₁	52	40	45	50	60	40

Table 2: Contd.,						
Al ₁₂	25	28	25	30	45	34
S.Em±	0.82	0.82	0.88	0.82	0.86	0.82
C.D. at 1%	2.28	2.28	2.47	2.28	2.44	2.28

Table .3 Variations in Colonies Growth of Different Isolates of *Alternaria Lini* on Different Culture Media

Media Isolates	PDA	Radish Agar Medium	Maize Meal Medium	Barley Meal Medium	Linseed Leaf Extract Medium	Carrot Agar Medium
Al ₁	Medium	Medium	Medium	Medium	Fast	Medium
Al ₂	Medium	Medium	Medium	Medium	Fast	Medium
Al ₃	Medium	Medium	Fast	Medium	Fast	Medium
Al ₄	Slow	Slow	Slow	Slow	Medium	Slow
Al ₅	Medium	Medium	Fast	Medium	Fast	Medium
Al ₆	Slow	Slow	Slow	Slow	Medium	Slow
Al ₇	Medium	Slow	Medium	Medium	Medium	Medium
Al ₈	Medium	Medium	Medium	Medium	Medium	Medium
Al ₉	Medium	Medium	Medium	Medium	Medium	Medium
Al ₁₀	Medium	Medium	Medium	Medium	Medium	Medium
Al ₁₁	Fast	Medium	Medium	Fast	fast	Medium
Al ₁₂	Slow	Slow	Slow	Slow	Medium	Slow

Table.4: Effect of Different Culture Media on the Appearance of Colonies of *Alternaria Lini* Isolates

Media Isolates	PDA	Radish Agar Medium	Maize Meal Medium	Barley Meal Medium	Linseed Leaf Extract Medium	Carrot Agar Medium
Al ₁	Thick cottony	Cottony	Compressed and thin	Cottony	Cottony	Cottony
Al ₂	Thick cottony	Cottony	Compressed and thin	Cottony	Cottony	Cottony
Al ₃	Cottony	Cottony	Compressed and thin	Cottony	Cottony	Feathery
Al ₄	Feathery	Cottony	Compressed and thin	Cottony	Cottony	Cottony
Al ₅	Cottony	Cottony	Compressed and thin	Feathery	Cottony	Feathery
Al ₆	Cottony	Cottony	Compressed and thin	Cottony	Cottony	Cottony
Al ₇	Cottony	Cottony	Compressed and thin	Fluffy	Cottony	Feathery
Al ₈	Cottony	Feathery	Compressed and thin	Cottony	Cottony	Feathery
Al ₉	Cottony	Cottony	Compressed and thin	Cottony	Cottony	Feathery

Table 4: Contd.,						
Al ₁₀	Feathery	Cottony	Compressed and thin	Cottony	Cottony	Feathery
Al ₁₁	Cottony	Cottony	Compressed and thin	Fluffy	Cottony	Cottony
Al ₁₂	Cottony	Cottony	Compressed and thin	Cottony	Cottony	Cottony

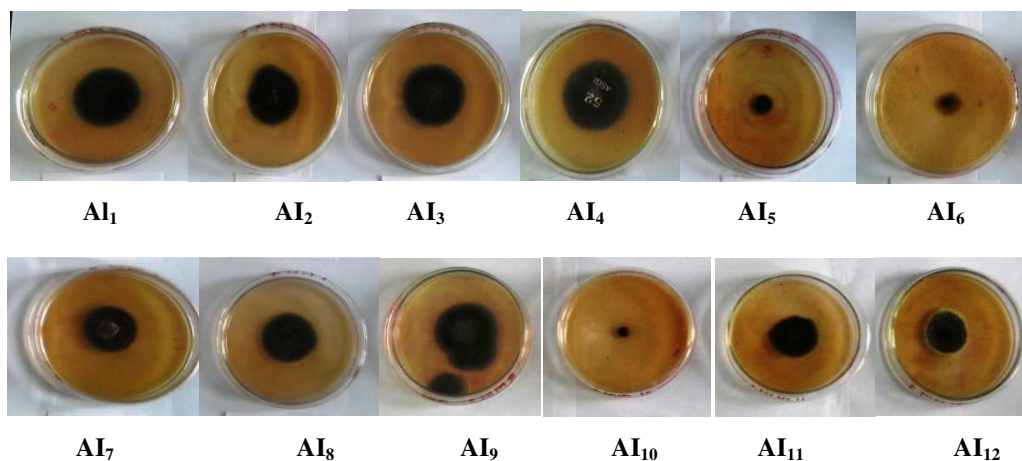


Figure 1: Colony Morphology of *A. Lini* Isolates on Carrot Agar Medium (Al₁.Patna, Al₂.Bilaspur, Al₃.Sultanpur, Al₄.Mauranipur, Al₅.Mashodha, Al₆.Kanpur, Al₇.Kangra, Al₈.Ranchi, Al₉.Mirzapur, Al₁₀.Gorkhpur, Al₁₁.Berhampur, Al₁₂.Kumarganj)

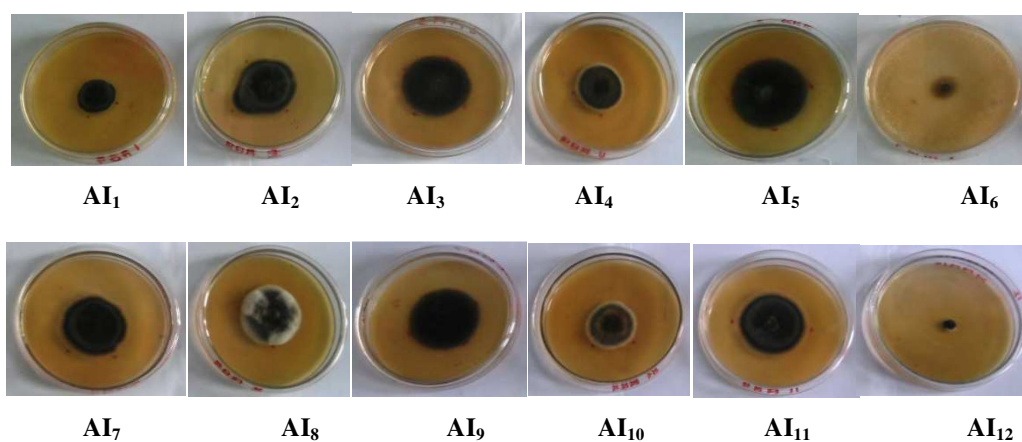
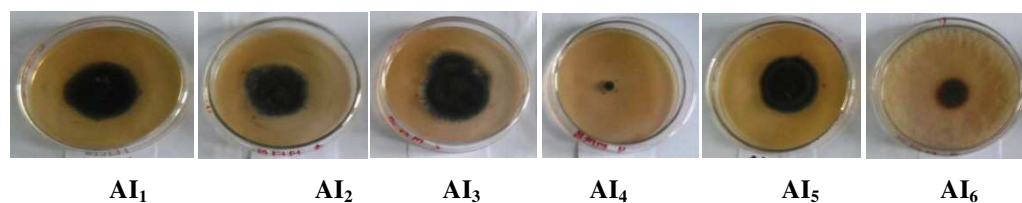


Figure.2: Colony Morphology of *A. Lini* Isolates on Potato Dextrose Agar Medium (Al₁.Patna, Al₂.Bilaspur, Al₃.Sultanpur, Al₄.Mauranipur, Al₅.Mashodha, Al₆.Kanpur, Al₇.Kangra, Al₈.Ranchi, Al₉.Mirzapur, Al₁₀.Gorkhpur, Al₁₁.Berhampur, Al₁₂.Kumarganj)



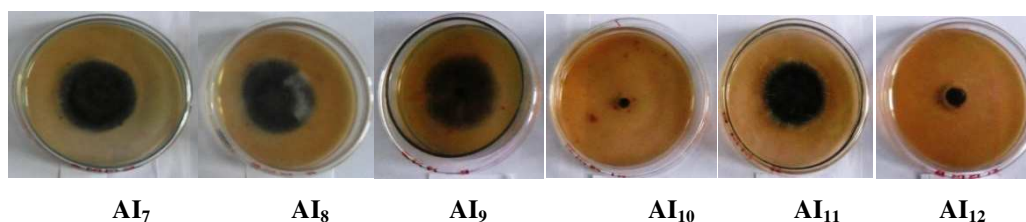


Figure 3: Colony morphology of *A. lini* isolates on Barley meal medium (AI₁.Patna, AI₂.Bilaspur, AI₃.Sultanpur, AI₄.Mauranipur, AI₅.Mashodha, AI₆.Kanpur, AI₇.Kangra, AI₈.Ranchi, AI₉.Mirzapur, AI₁₀.Gorkhpur, AI₁₁.Berhampur, AI₁₂. Kumarganj)

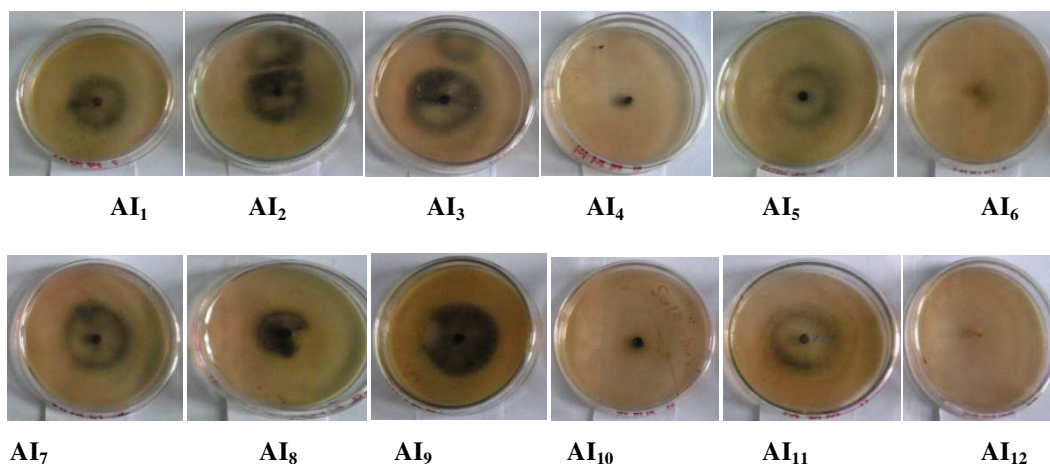


Figure 4: Colony Morphology of *A. Lini* Isolates on Maize Meal Medium (AI₁.Patna, AI₂.Bilaspur, AI₃.Sultanpur, AI₄.Mauranipur, AI₅.Mashodha, AI₆.Kanpur, AI₇.Kangra, AI₈.Ranchi, AI₉.Mirzapur, AI₁₀.Gorkhpur, AI₁₁.Berhampur, AI₁₂. Kumarganj)

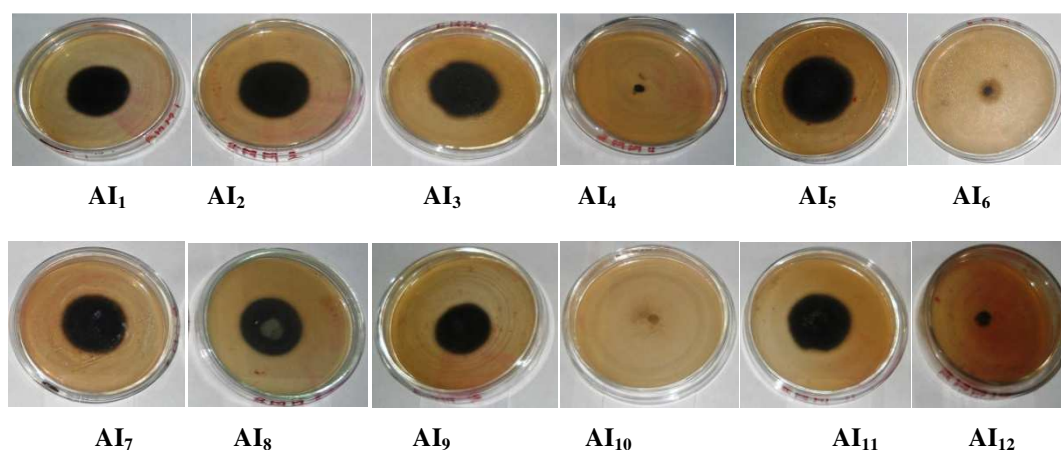
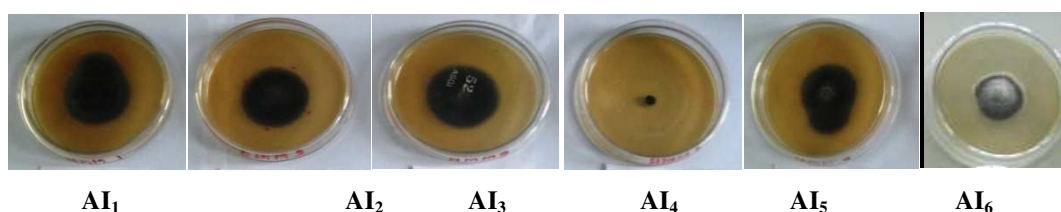


Figure 5: Colony morphology of *A. lini* isolates on Radish agar medium (AI₁.Patna, AI₂.Bilaspur, AI₃.Sultanpur, AI₄.Mauranipur, AI₅.Mashodha, AI₆.Kanpur, AI₇.Kangra, AI₈.Ranchi, AI₉.Mirzapur, AI₁₀.Gorkhpur, AI₁₁.Berhampur, AI₁₂. Kumarganj)



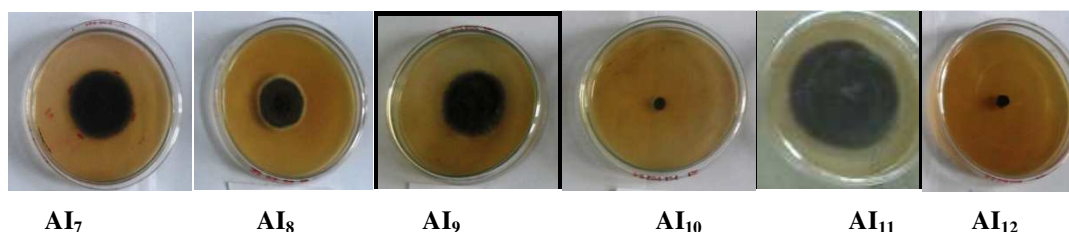


Figure 6: Colony Morphology of *A. Lini* Isolates on Linseed Leaf Extract Medium (AI₁.Patna, AI₂.Bilaspur, AI₃.Sultanpur, AI₄.Mauranipur, AI₅.Mashodha, AI₆.Kanpur, AI₇.Kangra, AI₈.Ranchi, AI₉.Mirzapur, AI₁₀.Gorkhpur, AI₁₁.Berhampur, AI₁₂. Kumarganj)

Morphological variability

Besides cultural variability of isolates on different culture media, morphological variability of conidia and conidiophores produced by them were also studied and discussed. Average length of conidia of *Alternarialini*, obtained from different isolates ranged between 23.26 μm (AI₇ of Kangra) to 45.72 μm (AI₁₁ of Berhampur) and width between 6.76 μm (AI₄ of Mauranipur) to 17.01 μm (AI₁₁ of Berhampur). Horizontal septa in conidia, obtained from different isolates were also found variable, which ranged between, on basis of mean from 1.86 (AI₈ of Ranchi) to 5.60 (AI₁₁ of Berhampur). Likewise, colonies colour and shape of conidia, also found variable in different isolates. Most of the conidia were found light brown colour (AI₁, AI₂, AI₃, AI₄, AI₆, AI₉, AI₁₁ and AI₁₂) and few were dark brown in colour (AI₅, AI₇, AI₈, and AI₁₀). Oval shape of conidia were observed in isolates AI₁, AI₂, AI₄, AI₅, AI₆, AI₇ and AI₁₀ obclavate type in isolates AI₃, AI₈ and AI₉, while AI₁₁ and AI₁₂ were noted clavate type. In general, the conidia obtained from most of the isolates on PDA were unbeaked, some were with rudimentary beaked and few were short beaked. Unbeaked conidia were obtained from isolates AI₁, AI₂, AI₄, AI₅, AI₆, AI₇, AI₈, and AI₁₁, short beaked from AI₃ and AI₉, while rudimentary beaked from AI₁₁ and AI₁₂, respectively (Table.5 and Fig.7). Concurrent with present finding Kumar *et al.* (2003) have also reported distinct appearance among the isolates of *Alternaria brassicae* of rapeseed- mustard, in terms of conidial length, width and number of septation at Haryana. They reported that average conidial length varied appreciably from 118.20 μm to 194.52 μm and identified 8 pathotypes. Mehta *et al.* (2003) worked on the morphological and pathological variation in rapeseed- mustard isolates of *A. brassicae* collected from different agroclimatic zone of India. They also reported variations in spore length and width, and indicated the existence of variability in the pathogen. Khan *et al.* (2007) isolated *A. brassicae* from the samples collected from different places of Aligarh district and reported variations in conidial length (112 to 185.60 μm), width (14.40 μm to 17.60 μm) and septation (5 to 16). Singh *et al.* (2009) also studied on morphological variation among 105 isolates *A. brassicae* collected from 18 district of Haryana. They found that, average conidial length and width ranged from 117.00 to 192 μm and 14.0 to 24 μm , respectively. Length of beak, horizontal septa and vertical septa varied from 42.0 to 116.0 μm , 6 to 9 and 1 to 3, respectively. Goyalet *et al.* (2011) and Sharma *et al.* (2013), also found variable morphology (length, width and number of septa) in different isolates of *A. brassicae* collected from different parts of country. Khulbe *et al.* (2011) and Pramila *et al.* (2014), studied the variability in different isolates of *A. brassicae*, collected from different part of Uttarakhand. They reported that conidial size ranged from 55.23 to 152.17 $\mu\text{m} \times 12.00$ to 88.40 μm and 105 to 135 \times 10 to 20 μm , respectively. The variation in conidial length, width, septa and beak, in case of *A. lini* in present studies supports the views of earlier workers. The studies therefore, indicate the existence of variability among the *A. lini* isolates collected from different part of country.

Like the conidial characters of *A. lini* morphological variability in conidiophores, were also recorded in respect of length, width, colour and number of septa. Average length and width of conidiophores, ranged between 33.00 μm (Al_7) to 81.50 μm (Al_{12}) and 4.45 μm (Al_7) to 9.27 μm (Al_3), respectively. Colour of conidiophores was observed light brown to dark brown. Average septation in conidiophores, ranged between 3.33 (Al_7 of Kangra) to 7.53 (Al_{12} of Kumarganj) (Table.6).

As per literature available, it was noted that most of the earlier pathologist working with different *Alternaria* spp., have studied the variations in conidial characters only. None have taken into consideration, about the variation in characters of conidiophores. During present studies, variation in characters of conidiophores have also been taken into consideration and found variable.

Table 5: Morphological Characters of Conidia

Different isolates	Length (μm)		Width (μm)		Colour	Shape	Horizontal septa		Beak
	Range	Average	Range	Average			Range	Average	
Al_1	22.50-30.00	27.33	14.00-15.50	15.00	Light brown	oval	2-3	2.60	Unbeaked
Al_2	22.50-26.50	23.73	11.30-15.00	14.01	Light brown	oval	3-4	3.13	Unbeaked
Al_3	22.50-30.00	28.00	7.50-11.33	9.02	Dark brown	obclavate	2-3	2.40	Short beaked
Al_4	30.00-33.80	30.76	3.80-7.50	6.76	Light brown	oval	2-3	2.33	Unbeaked
Al_5	22.50-30.00	26.50	7.50-11.30	8.70	Dark brown	oval	3-4	3.40	Unbeaked
Al_6	22.50-30.00	28.00	7.50-11.30	8.26	Light brown	oval	2-3	2.46	Unbeaked
Al_7	22.50-26.30	23.26	15.00-18.80	15.76	Dark brown	oval	2-3	2.86	Unbeaked
Al_8	30.00-33.80	31.01	7.0-8.0	7.50	Dark brown	obclavate	1-2	1.86	Unbeaked
Al_9	22.50-26.30	24.04	15.00-18.80	16.06	Light brown	obclavate	3-4	3.53	Short beaked
Al_{10}	22.50-30.00	27.00	7.50-11.30	8.00	Dark brown	oval	2-3	2.46	Unbeaked
Al_{11}	45.00-48.00	45.72	15.00-18.80	17.01	Light brown	clavate	5-7	5.60	Rudimentary beaked
Al_{12}	22.50-30.00	25.50	7.50-11.30	10.00	Dark brown	clavate	2-3	2.52	Rudimentary beaked
S.Em \pm		0.62		0.30				0.17	
C.D.at 1%		1.74		0.83				0.48	

Table 6: Morphological Characters of Conidiophores

Different isolates	Length (μm)		Width (μm)		Colour	Horizontal septa	
	Range	Average	Range	Average		Range	Average
Al_1	60.00-67.50	63.50	3.80-7.50	5.52	Dark brown	4-5	4.26
Al_2	60.00-67.50	62.50	3.80-7.50	5.77	Dark brown	4-5	4.26

Table 6: Contd.,							
Al ₃	75.00-90.00	79.5 0	7.50- 11.30	9.27	Dark brown	6-8	6.83
Al ₄	52.50-60.00	56.5 0	6.00-7.50	7.10	Light brown	5-7	6.09
Al ₅	75.00-82.90	78.0 0	7.50- 11.30	9.02	Dark brown	6-8	6.86
Al ₆	45.00-48.80	46.2 6	6.00-7.50	7.10	Light Brown	3-4	3.53
Al ₇	30.00-37.50	33.0 0	3.80-7.50	4.54	Light brown	3-4	3.33
Al ₈	33.80-37.50	36.0 0	6.00-7.50	7.00	Dark brown	3-4	3.40
Al ₉	41.30-48.80	45.2 6	7.50- 11.30	9.02	Light brown	4-6	3.86
Al ₁₀	41.30-48.80	44.5 0	7.50- 11.30	8.76	Light brown	3-5	3.40
Al ₁₁	75.00-90.00	77.8 3	7.50- 11.30	8.26	Dark brown	6-8	6.80
Al ₁₂	75.00-90.00	81.5 0	7.50- 11.30	8.51	Dark brown	7-9	7.53
S.Em±		0.30		0.44			0.45
C.D.at 1%		0.87		1.23			0.61

Patna isolate (Al₁)Bilaspur isolate (Al₂)Sultanpur isolate (Al₃)Mauranipur isolate (Al₄)Mashodha isolate (Al₅)Kanpur isolate (Al₆)Kangra isolate (Al₇)Ranchi isolate (Al₈)Mirzapur isolate (Al₉)

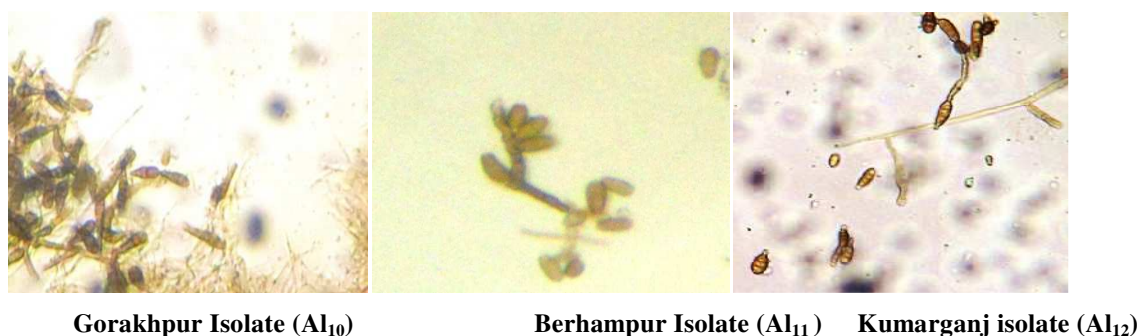


Figure 7: Morphological Characters of Isolates (Al₁, Al₂, Al₃, Al₄, Al₅, Al₆, Al₇, Al₈, Al₉, Al₁₀, Al₁₁ And Al₁₂)

CONCLUSIONS

The diseased samples were collected from thirteen places of India. Out of thirteen samples, pathogen causing disease could be isolated successfully from 12 samples and one obtained from Jammu (J&K) could not be isolated. These isolates were purified by single spore technique method and identified as *Alternaria lini*. All the isolates were cultured separately on different media and showed variable reaction in respect of colonies colour, appearance, growth pattern, shape of colonies, margin, zonation, sporulation and radial growth. On all the test media the colonies colours of different isolates were observed as whitish, dirty white, light brown and dark brown. Radial growths of colonies formed by different isolates of *A. lini* were recorded after 7 days of inoculation found variable. Isolates Al₁₁ collected from Berhampur (W.B.) showed maximum radial growth and isolates Al₆ obtained from Kanpur (U.P.) showed minimum radial growth on all the test media. Shape of colonies formed by all the isolates on each media was circular. Colonies growths were varied from slow to fast on different culture media in case of all the isolates. Sporulation in different isolates on different culture media was also found variable. Some isolates showed early sporulation, some medium and some late on different media. Appearances of colonies formed on different media by different isolates were cottony, feathery, fluffy or compressed & thin. Average length of conidia of *A. lini* obtained from different isolates, ranged between 23.26µm (Al₇ of Kangra) to 45.72 µm (Al₁₁ of Berhampur) and width between 6.67 µm (Al₄ of Mauranipur) to 17.01 µm (Al₁₁ of Berhampur). Average number of horizontal septa, in conidia of different isolates ranged between 1.86 (Al₈ of Ranchi) to 5.60 (Al₁₁ of Berhampur). Most of conidia obtained from different isolates were found light brown and few were dark brown in colour. Shape of conidia were also found variable and noted as oval, obclavate and clavate type. The conidia obtained from most of the isolates on PDA were unbeaked (Al₁, Al₂, Al₄, Al₅, Al₆, Al₇, Al₈, Al₁₀), some were with rudimentary beaked (Al₁₁ and Al₁₂) and few were short beaked (Al₃ and Al₉). Morphological characters of conidiophores were also found variable in respect of length (33.00 to 81.50µm), width (4.54 to 9.27µm), colour (light brown to dark brown) and number of septa (3.33 to 7.53).

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